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The Post-impoundment Area and Bathymetry of Cedar Lake, Manitoba.

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ABSTRACT

The approximate post-impoundment area of Cedar Lake, exclusive of the Cross Bay area, at a mean lake elevation of 256 m ASL was 244,000 ha. The estimated depth of water on Cedar Lake, as described above, was 4.18 m. Considering the lake basin encompassed by the old shoreline and at a mean lake elevation of 256 m ASL (the full supply level of the Grand Rapids Dam reservoir), the mean depths of the original lake basin and the south basin of Cedar Lake are 7.0 and 7.6 m, respectively. The mean depth of the south basin was 1.8 m greater than the depth prior to flooding and at the mean lake elevation of 253 m.

The mean surface elevation of Cedar Lake varies from 253 to 256 m ASL at minimum and full reservoir levels. Drawdown of Cedar Lake begins in the late fall and early winter and minimum pool is normally reached by April. Full supply level on Cedar Lake is achieved by September.

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INTRODUCTION

Cedar Lake lies on the northwestern corner of Lake Winnipeg (Fig. 1) at 53° 18'N latitude and 100° 04'W longitude (Anonymous, 1973). The Saskatchewan River flows through Cedar Lake and Cross Bay into Lake Winnipeg. Cross Bay is the eastern extension of Cedar Lake. The Grand Rapids Hydro-electric Generating Station and spillway, which were completed in 1965, are situated on the eastern end of Cross Bay a short distance upstream from Lake Winnipeg. The Grand Rapids Hydro-electric Dam regulates Cedar Lake within 3.05 m of its pre-flooded long-term average elevation (approximately 253.5 m ASL).

Webb (1963) described Cedar Lake prior to the beginning of flooding in 1964 as consisting of two distinct regions; a north arm and a south basin which formed the major portion of the lake. Depths in the north arm were mainly less than 3.05 m and the maximum depth was 5.5 m. The south basin had an average depth of 5.8 m and a maximum depth of 10m. The pre-impoundment area of Cedar Lake was 840 km^2 (Anonymous, 1973).

The water level of Cedar Lake was raised from 253 to 256 m ASL in 1965 as a result of the flooding by the Grand Rapids Dam. It was intended to operate the reservoir at a full supply level of 257.3 m (Anonymous, 1961). However, present regulations stipulate a full supply level of 256.6 m, but water levels may approach 257 m ASL. With the water level on Cedar Lake raised to 256 m, extensive flooding of adjacent land has occurred forming new shorelines. The new shoreline boundaries vary depending upon the degree of annual drawdown.

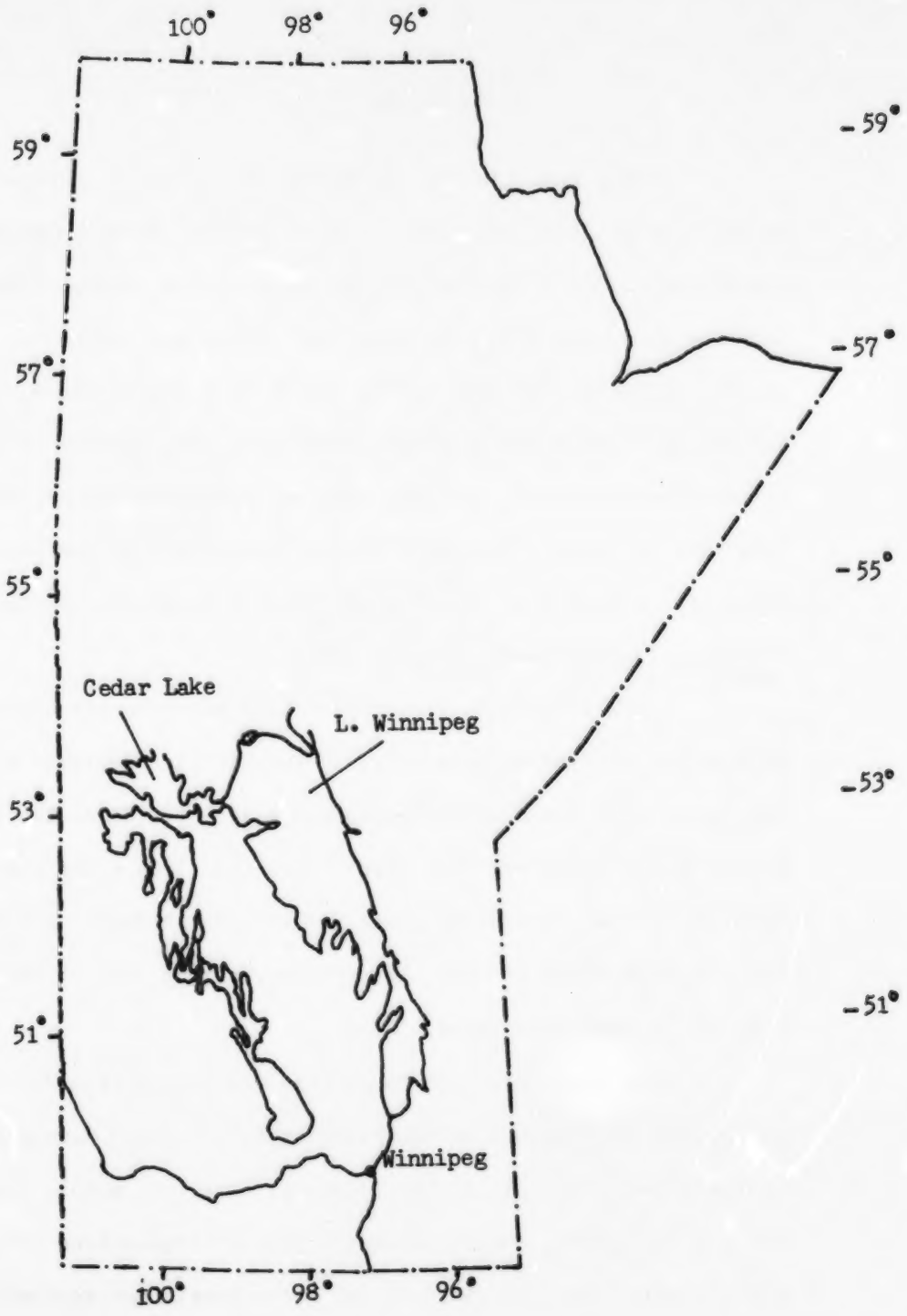


Figure 1. Location of Cedar Lake in Manitoba.

The principal objective of this report is to determine the mean depth of Cedar Lake (excluding Cross Bay) at full supply level based on hydrographic surveys conducted in 1962 and 1971. (The Cross Bay area of Cedar Lake was sounded in 1975.(A. J. Derksen, unpublished data)). A secondary objective of this report is to estimate the post-flooded area of Cedar Lake.

MATERIALS AND METHODS

The contour map of a major portion of Cedar Lake and determination of its bathymetry following flooding was based upon the combined results of sounding surveys conducted in 1962 and 1971. Although the 1971 survey was more carefully done, results from it alone could not be used since it considered only half of the south basin of Cedar Lake. The less accurate 1962 survey considered all of the south basin and much of the north arm of Cedar Lake, but the results had to be adjusted since they were obtained prior to flooding by the Grand Rapids Dam.

Contour Mapping

A depth contour map of Cedar Lake was made by Webb (1963) based upon hand-line depth soundings taken along approximately 40 pre-determined compass-oriented transects (Fig. 2). The results of this survey are subject to some error, since although the transects were compass-oriented visual fixes on shoreline reference points could not be maintained. Several transects were in excess of 30 km in length. Although the 1962 soundings were not referenced to a bench mark, the level of Cedar Lake at the time soundings were taken was near its long term average (253 m ASL).

The only depth soundings of Cedar Lake after flooding were taken in August and September, 1971. The sounding procedure employed echo-sounders and two-way radio equipped boats as well as transits at shoreline vantage points to direct the sounding boats along predetermined transects. To reduce the length of the transects, the south basin of Cedar Lake was divided into two

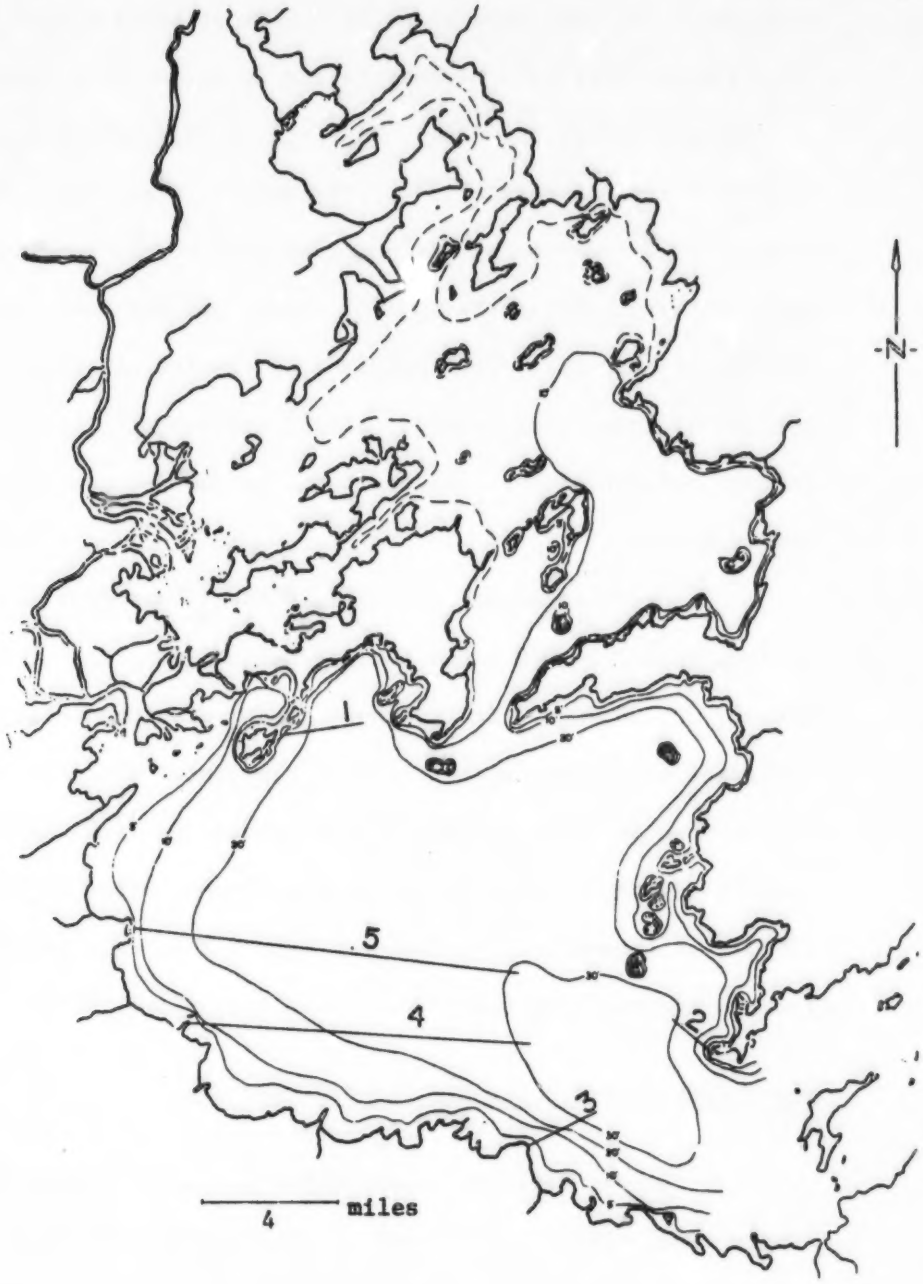


Figure 2. Depth contour map of Cedar Lake prior to flooding (from Webb, 1963). (Lines 1 to 5 are sampling transects).

sections. This was done by using a line of bouys placed approximately 1.6 km apart (Fig. 3). Transects ran up to the bouy line and not all the way across the lake. In spite of this modification, the longest transects were still approximately 24 km long. This necessitated locating the transits on high towers and fitting the boats with raised targets so that visual contact could be maintained through the transit. The locations of transit stations and the portion of Cedar Lake sounded in 1971 are shown in (Fig. 3). A greater portion of the lake could not be sounded due to inclement autumn weather.

Depth soundings recorded in the 1971 survey were plotted as feet on a 1:50,000 scale outline map of Cedar Lake (after flooding). The 10, 20, 30 and 40 foot contour lines were then sketched in. Following this, the depth contours were continued into the areas not sounded in 1971, but which were sounded in 1962. This was done by adding 10 feet to the contour lines plotted by Webb (1963). The resulting contour map formed the basis for determining the average post-impoundment depth of Cedar Lake.

Depth determination for the flooded land area

It was estimated that at the initially proposed full supply level (257.2 m ASL) much of the Saskatchewan River Delta upstream of Cedar Lake would be inundated by 0.61 to 3.66 m of water (Anonymous, 1961). However, since the maximum pool is maintained at 0.61 m below the 257.2 m level, the flooded land area (Fig. 3) was assumed be under 0.5 to 3.05 m of water. Anonymous (1961) describes the Saskatchewan River Delta as flat to slightly undulating. The only high grounds consisted of the natural river

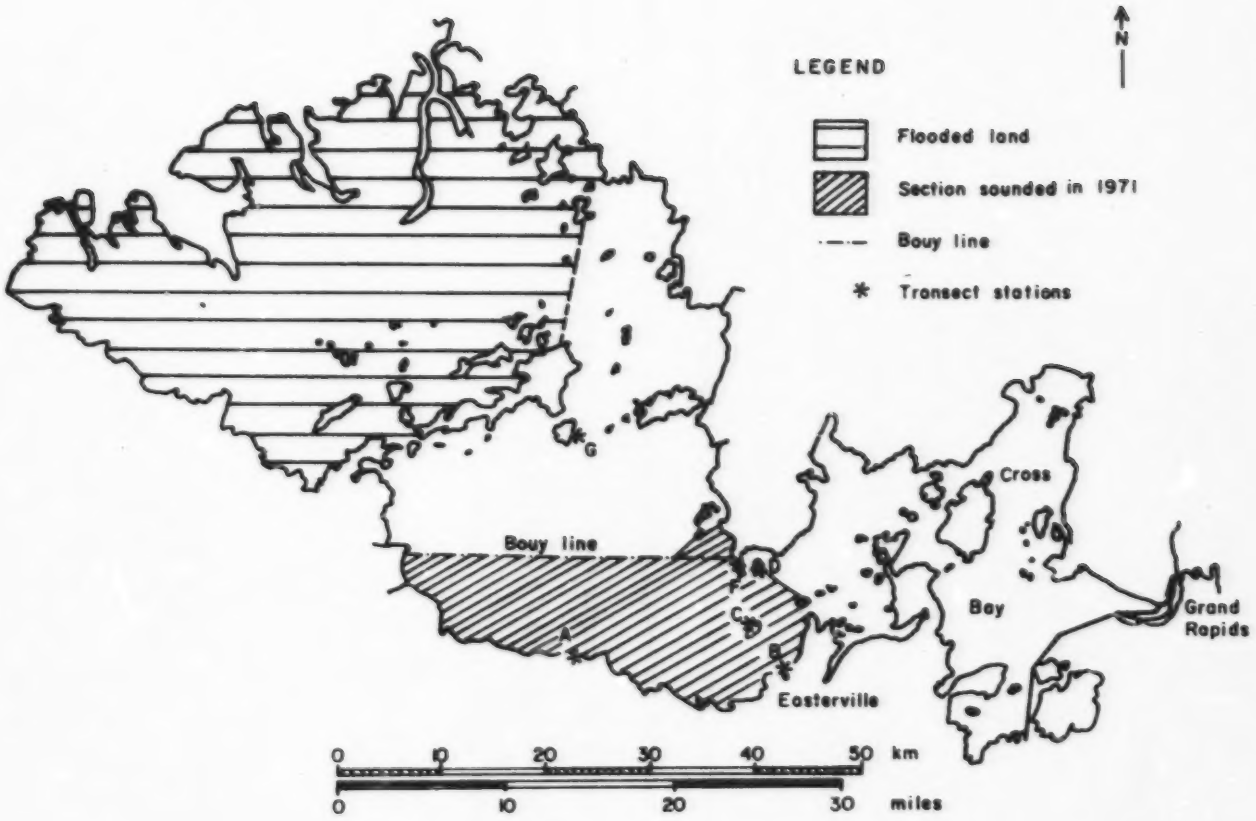


Figure 3. Location of bouy line, transect stations, and portion of Cedar Lake that was sounded in 1971.

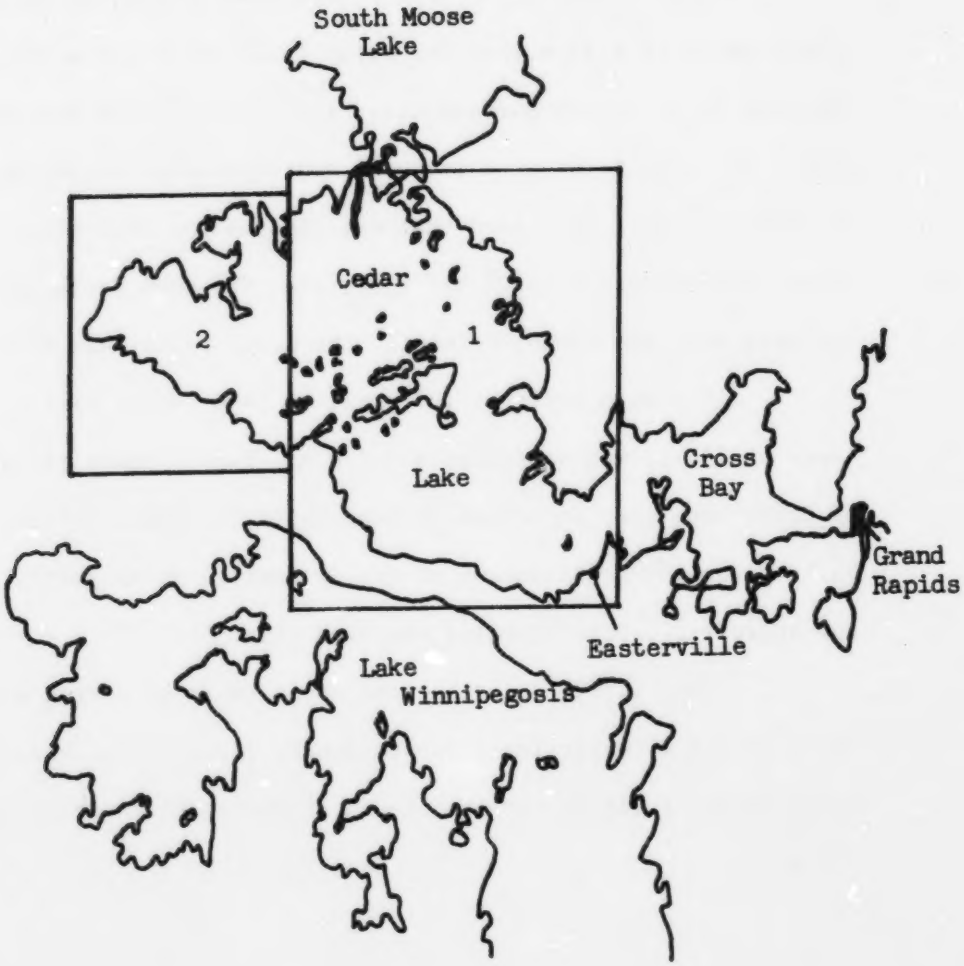
levees along the major streams and the occasional limestone outcroppings. Average water depths in the flooded Delta area would not likely exceed 1.0 m.

Planimetry

A Hewlett Packard 9100 B calculator and 9107 B digitizer were used to calculate the area of Cedar Lake. Accuracy is to .01 inches. Two maps, each having a scale of 1:100,000 were used. These maps were photographically reduced from maps which had a scale of 1:50,000[1]. A key map (Fig. 4) shows the coverage of the two maps.

Area for the maps (Fig. 5) were measured in square inches and then converted to hectares. Boundaries of shorelines, islands and contour intervals were measured twice. The average between the two measurements was used. Islands with areas less than .01 square inches weren't calculated, since the planimeter couldn't measure these.

[1] Published by Surveys and Mapping Branch, Mines, Resources and Environmental Management, July 1971.



Scale- 1:1,000,000

Figure 4. Key map showing the area covered by map 1 and map 2 of Figure 5.

RESULTS

Cedar Lake has an approximate area of 244,000 ha and a mean depth of 4.18 m when the water level is at 256 m ASL. The area is for water surface only, i.e. island areas are excluded (Table 1). The total area included approximately 120,000 ha of flooded land. Most land that was flooded was in shallow water (between 0.5 to 3.05 m); therefore, the mean depth of the original lake basin, primarily the south basin, was affected.

The mean depth of the original lake basin, with a water level at 256 m, was approximately 7.0 m. Fig. 6 shows the section of Cedar Lake used to calculate mean depth for the original lake basin. For the continuation of the 10 foot (3.05 m) contour interval, the shoreline before flooding was used (Fig. 5).

Webb (1963) describes the south basin as having a mean depth of 5.8 m (water level approximately 253 m ASL). With the water level at 256 m, the mean depth of the south basin is approximately 7.6 m.

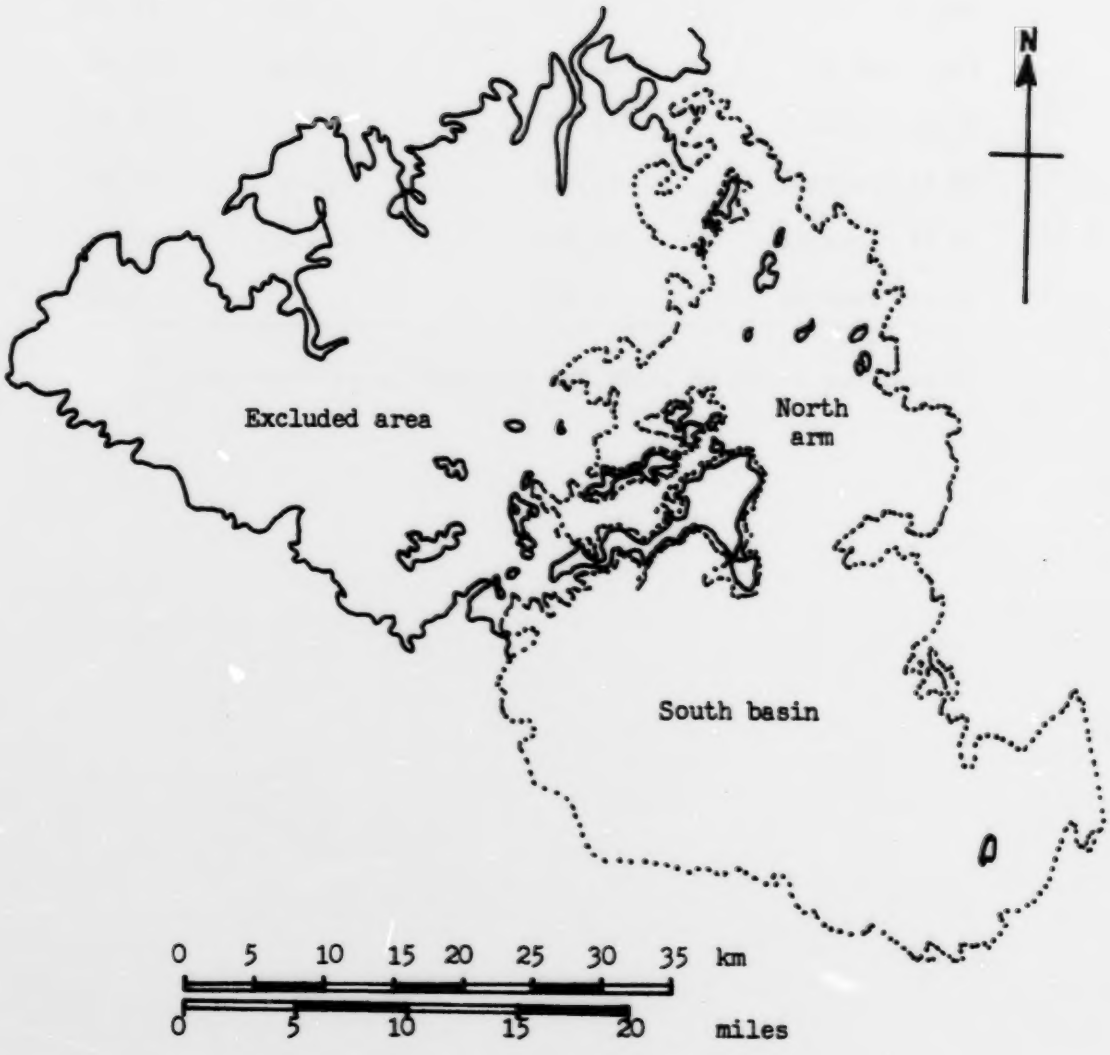


Figure 6. Section of Cedar Lake used to calculate mean depth for the original lake basin is within dotted line.

Table 1. Water surface, contour and island areas for Cedar Lake with mean water level of 256 metres (841 feet) ASL[1].

Boundary	Water surface area	Island area	Total
Map 1	179,654	9,379	189,033
Map 2	64,172	304	64,476
Map 1 and 2	243,826	9,683	253,509
10 ft. contour	112,780	2,120	114,900
20 ft. contour	65,420	433	65,853
30 ft. contour	40,644	149	40,793
40 ft. contour	2,882	-	2,883

[1]actual map scale of 1:100,042 was used in calculations.

DISCUSSION

The area for Cedar Lake was found to be approximately 2400 km^2 with a water level of 256 m ASL. Statistics Canada (Anon., 1978) still list Cedar Lake as having an area of 1352 km^2. However, comparison with a second reference (Anon., 1973) shows that the latter area is for the old lake bed.

The water level of Cedar Lake is never fully under natural environmental control which must be considered when measuring the productivity of the lake. With normal average annual precipitation, Manitoba Hydro controls the water level between approximately 253 to 256 m ASL. Continual drawdown during winter months by the generating station reduces water levels. Consequently, shoreline boundaries created by flooding diminish accordingly. At minimum pool Cedar Lake is approximately 253 m which is the average annual water level prior to flooding. This low is normally reached by April.

In summer, levels are replenished by spring thaw and run-off from the watershed with peak levels usually reached by September. Therefore, the surface area and volume of Cedar Lake would be greater in summer than winter months. Since the water level is normally drawn down to or near 253 m during winter, the mean depth of the south basin would be 1.5-2.0 m more in summer than winter.

SUMMARY

1. Cedar Lake (excluding Cross Bay) has a post-impoundment area of approximately 244,000 ha and a mean depth of 4.18 m when the water level is at 256 m ASL.

2. The mean depth of the original lake basin with a lake level of 256 m ASL is approximately 7.0 m.

3. The mean depth of the south basin (water level approximately 253 m ASL) is 5.8 m.

4. The mean depth of the south basin with a water level of 256 m ASL is approximately 7.6 m.

ACKNOWLEDGMENT

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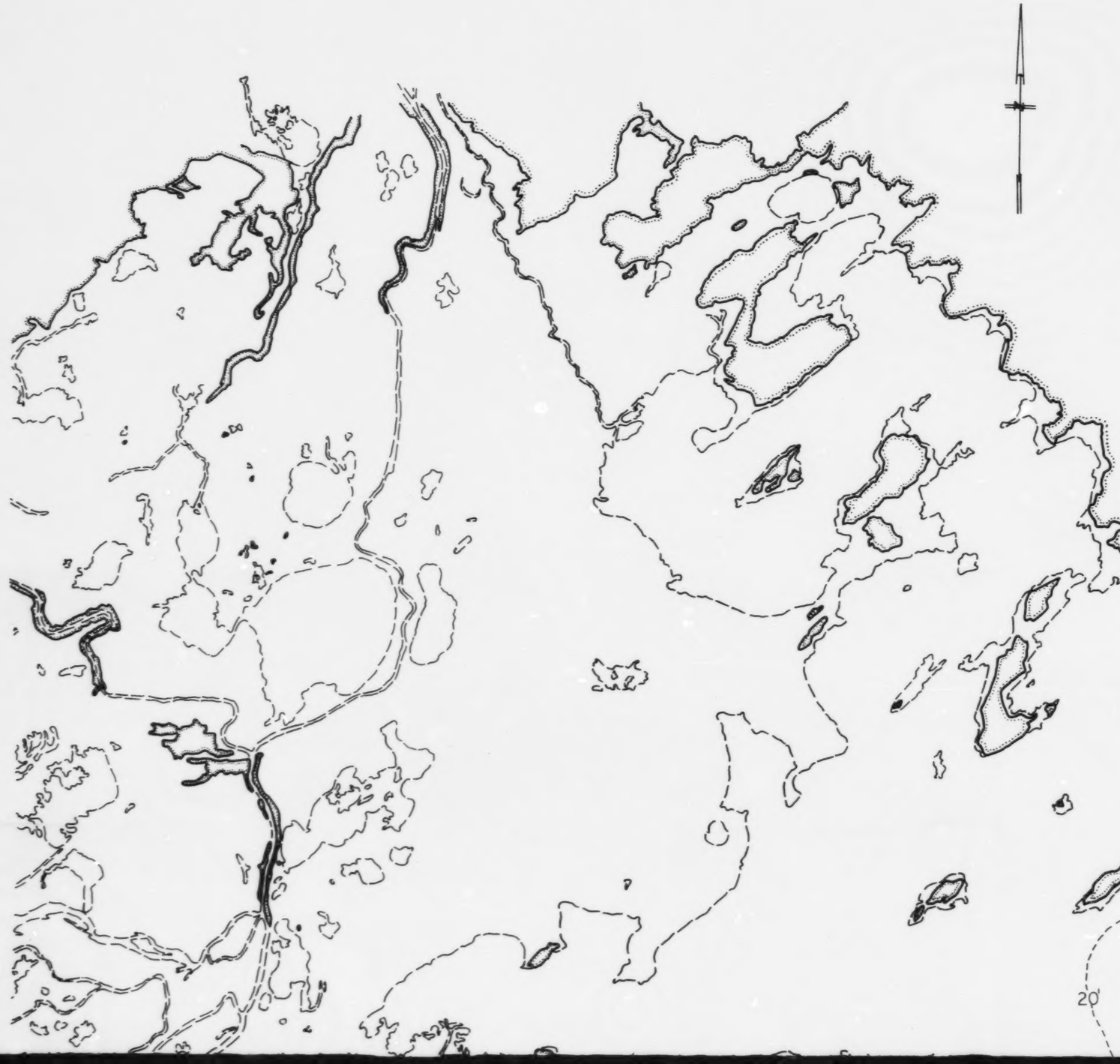
CEDAR LAKE



1 0 1 2 3 MILES

1 0 1 2 3 4 KILOMETRES

LEGEND

SHORELINE

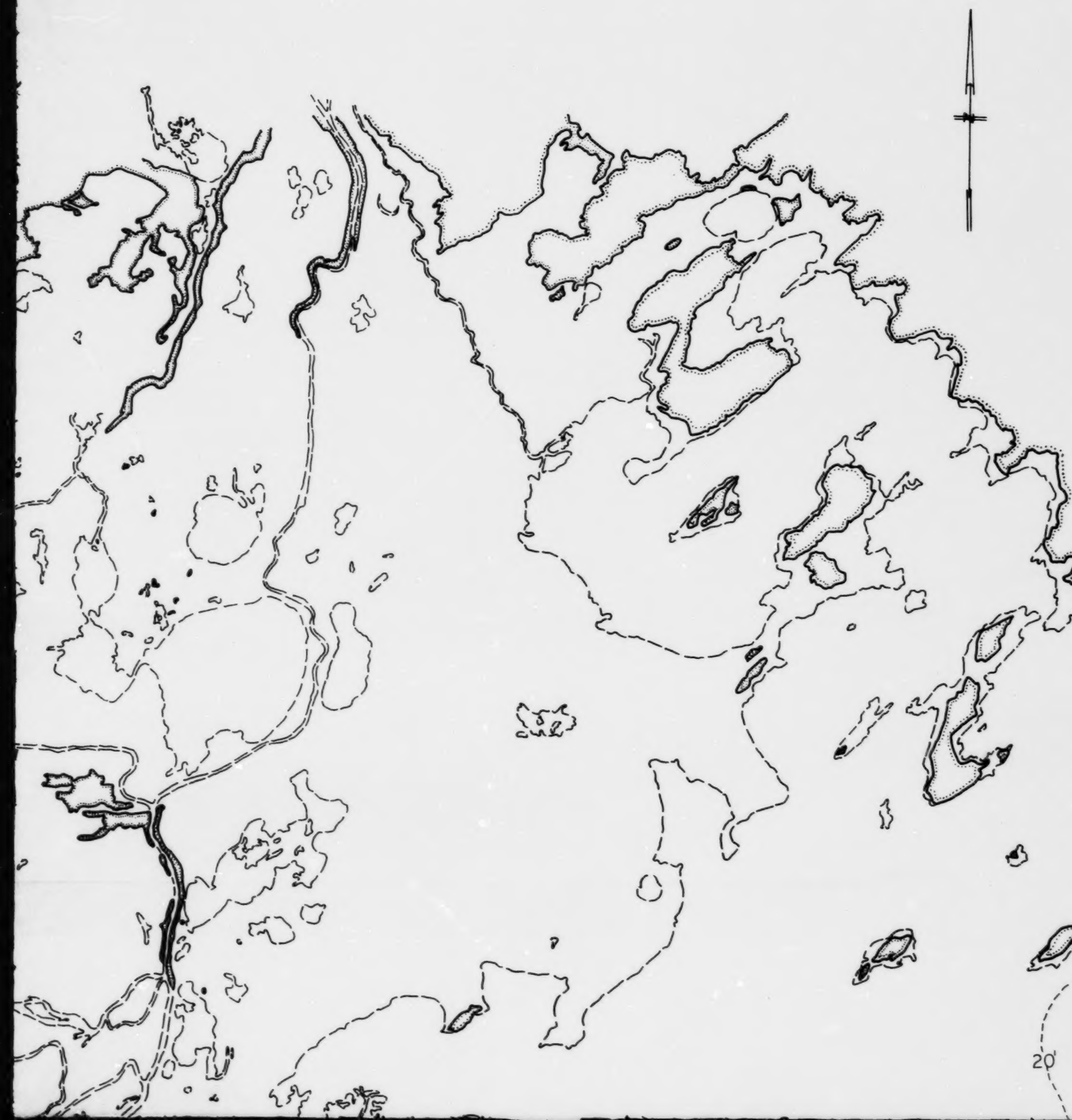
SHORELINE BEFORE FLOODING

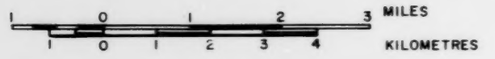
DEPTH CONTOURS (Feet)

- POST IMPOUNDMENT SOUNDING

- ESTIMATED FROM PRE IMPOUNDMENT SOUNDING

CEDAR LAKE





LEGEND

SHORELINE

SHORELINE BEFORE FLOODING

DEPTH CONTOURS (Feet)

- POST IMPOUNDMENT SOUNDING

- ESTIMATED FROM PRE IMPOUNDMENT SOUNDING

10'
20'
30'

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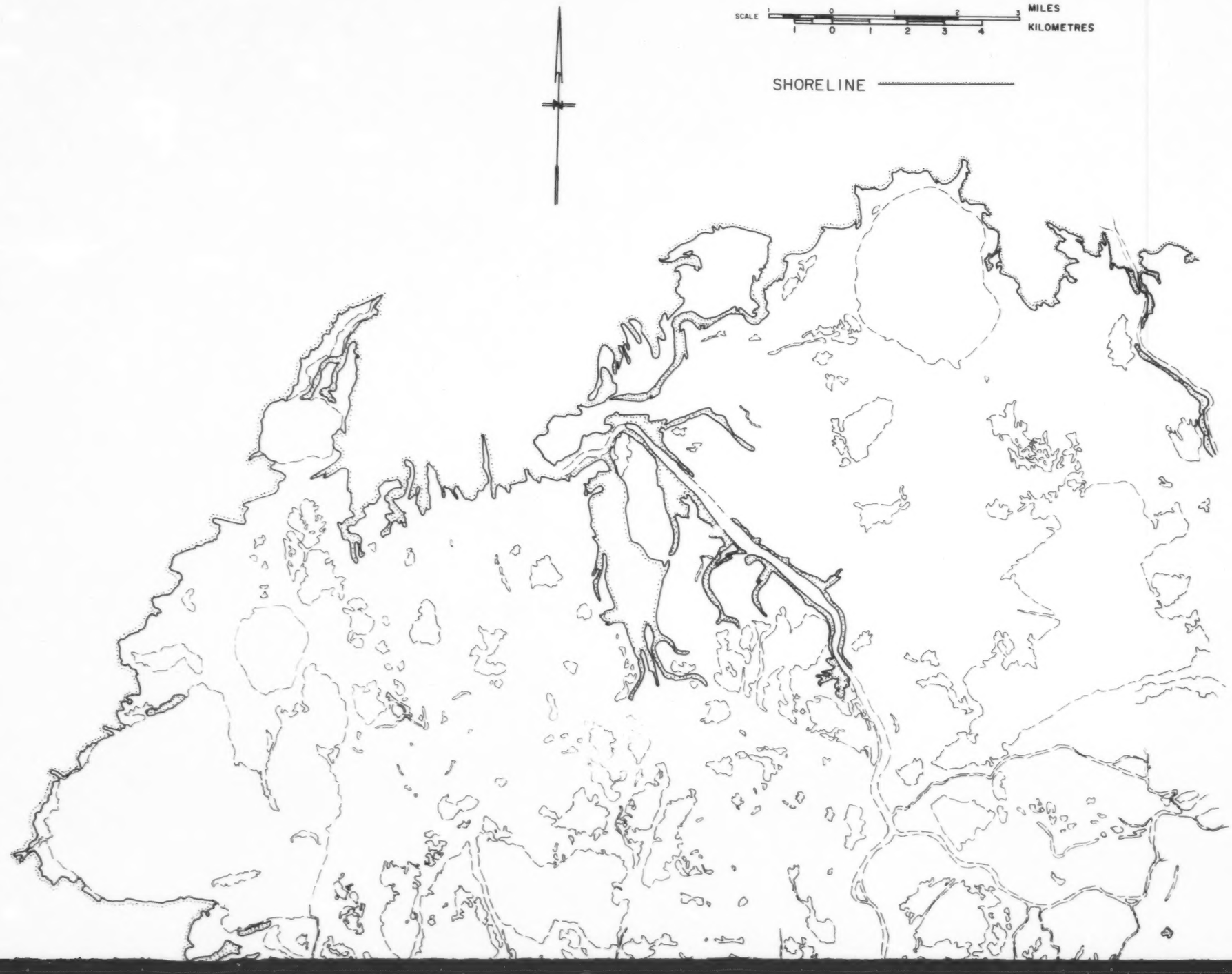
LAKE
WINNIPEGOSIS

LAKE
WINNIPEGOSIS

EASTERVILLE

CEDAR LAKE



Surveys & Mapping Br M R & E M July 1971